ORIGINS OF SINUOUS AND BRAIDED CHANNELS ON ASCRAEUS MONS, MARS – A KECK GEOLOGY CONSORTIUM UNDERGRADUATE RESEARCH PROJECT. A.P. de Wet[1], J. E. Bleacher[2], and W.B. Garry[3]. [1]Franklin & Marshall College, Lancaster, PA, 17603, [2]Planetary Geodynamics Laboratory, Code 698, NASA GSFC, Greenbelt, MD, 20771, [3]Center for Earth and Planetary Studies, Smithsonian Institution, National Air and Space Museum MRC 315, Washington, DC, 20013.

Introduction: Water has clearly played an important part in the geological evolution of Mars. There are many features on Mars that were almost certainly formed by fluvial processes – for example, the channels Kasei Valles and Ares Vallis in the Chryse Planitia area of Mars are almost certainly fluvial features. On the other hand, there are many channel features that are much more difficult to interpret – and have been variously attributed to volcanic and fluvial processes [1, 2]. Clearly unraveling the details of the role of water on Mars is extremely important, especially in the context of the search of extinct or extant life. In this project we built on our recent work in determining the origin of one channel on the southwest rift apron of Ascraeus Mons (Fig. 1) [1]. This project, funded by the Keck Geology Consortium and involving 4 undergraduate geology majors took advantage of the recently available datasets to map and analyze similar features on Ascraeus Mons and some other areas of Mars. A clearer understanding of how these particular channel features formed might lead to the development of better criteria to distinguish how other Martian channel features formed. Ultimately this might provide us with a better understanding of the role of volcanic and fluvial processes in the geological evolution of Mars.

The Keck Geology Consortium is a multi-college collaboration (18 member schools) focused on enriching undergraduate education by development of high-quality research experiences. Now in its 24th year, the Keck Geology Consortium has been a fundamental component of the undergraduate-research landscape since its inaugural projects in 1987. In over 120 sponsored projects to date, the Consortium has supported over 1000 undergraduate students from more than 90 schools across the nation. Programs have involved over 120 faculty representing 50 different colleges, universities, governmental agencies, and businesses. Funding has included NSF, ExxonMobil and the member colleges. The typical Keck project involves 4 weeks of field and/or laboratory study over the summer, which is then followed by individual student independent research projects during the subsequent academic year. The results are presented at the annual Keck Research Symposium in Geology, published online, and our projects are presented at this conference [3,4,5].

Previous work: The observations of sinuous channels on the Moon and Mars has led to debates over their formation either as a result of fluvial or volcanic processes. This debate demonstrates the similar characteristics of fluvial and volcanic channels and their products [6]. Recently we presented evidence that suggests that at least one channel system on Ascraeus Mons, previously interpreted to have formed by fluvial processes [2], was likely formed by flowing lava [1].

Our prior study focused on a channel exposed on the east side of the southwest apron of Ascreaus Mons (Fig. 1). Earlier studies by us [7, 8] and other researchers [2, 9] had suggested that the channel resulted from fluvial erosion. These studies were hampered by the limited data available at the time which meant that only the proximal part of the feature could be studied. The channel originates from a NE trending fissure with a possible relationship to a larger rille to the North. The fissure does not display a topographic "cap" typical of nearby small volcanic vents. The channel is traceable for >270 km and we observe unique morphologies along the proximal, medial, and distal sections of the flow.

The proximal section extends ~60 km from the fissure and displays anabranching, braided and hanging channels, terraced channel walls, no levees, "streamlined" islands, and flow margins that are difficult to detect or are embayed by younger materials. The medial section extends from 60-170 km. Here the channel is composed of one sinuous trench that also lacks clear levees. Generally this section of channel is surrounded by a smooth surface but sometimes shows minor leveed channels leading away from the main channel, probably due to overflow. Flow margins are difficult to determine and are sometimes embayed by younger materials. The distal section extends from 170 to >270 km and displays a significantly different morphology. At 170 km the slope decreases from 0.7-1º towards the fissure to 0.3-0.6º. Here, the channel is located along the axis of a ridge that exceeds 40 m in height. In some locations the channel is roofed over. Furthermore, rootless vents are located along the axis of the ridge. These rootless vents display topographic "caps" up to 1 km in diameter and radiating flows, some extending for several kilometers.

Visual inspection of the Ascraeus channel's proximal section shows braided and hanging channels, terraced walls, and streamlined islands all of which have led many to suggest an origin involving fluvial activity based solely upon morphologic inferences. However, new image data enabled a complete view of the channel, including its distal portions, which display a topographic ridge, well defined flow margins, roofed

channel sections, and rootless vents. We suggested that these features are indicative of a volcanic origin for the distal portion of this channel. And thus the whole feature is volcanic in origin [1]. The Keck project is expanding on this earlier study by examining other channels on Ascraeus and in other locations on Mars (Fig 1).

Goals and Significance of the project: The focus of the Keck project is to study the entire southwest rift apron of Ascraeus Mons. We wanted to know if there are other channels that display similar features to the one we studied and whether these channels can be ascribed to volcanic or fluvial processes. As such, the objective is to understand the distribution of similar channel networks and their relative temporal relationship to other features. We hoped to be able to develop criteria that can be applied to Martian channel features in order to distinguish their mode of formation. Although we have concluded that one specific feature that was previously attributed to fluvial activity, is actually volcanic, it is important that we do not overextend this inference to suggest that all features in the area might share a similar history without conducting the necessary mapping.

Student projects: Research Questions: 1) What are the characteristics and distribution of channels on Ascraeus? What are the characteristics of the proximal, medial and distal parts of each channel? 2) What are the similarities and differences between the channels - do all the channels have the same basic morphology? What are the differences? Is there a relationship between the morphology and age of the features? 3) What is the origin of the channels – volcanic or fluvial or some combination of both, or another completely different mechanism? 4) How do these channels compare to channels on similar volcanoes in the Tharsis area? What about other areas of Mars? 5) How do these channels compare to Martian channels that are generally agreed to be fluvial in origin? 6) Can we develop better criteria to distinguish volcanic from fluvial channels on Mars? 7) What do these channels tell us about the geological evolution of Ascraeus? The Tharsis Montes area? Mars generally? 8) If unique types of channels are identified, did they form at one specific period of time in Martian history, or are they stratigraphically and temporally contemporaneous with other eruptions and channel forming events on Ascraeus Mons?

Project details: The student projects comprised of two components: Part 1 - the summer research component, and Part 2, the following academic year component. Part 1 focused on mapping the Ascraeus Mons rift apron (Fig 1). The students focused on the following goals and tasks: 1) Downloaded, georeferenced and assemble a dataset in ArcGIS. 2) Recognized and developed criteria, and mapped the

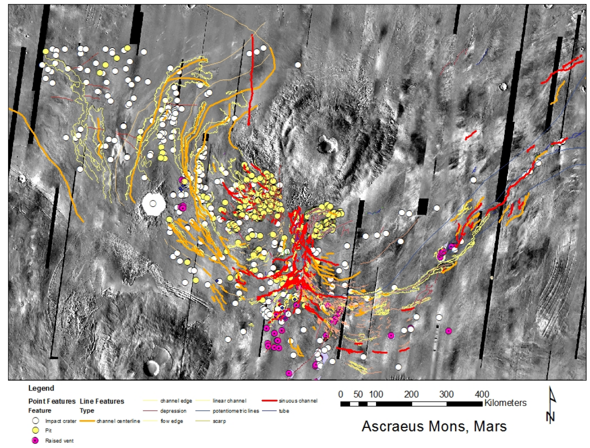

Figure 1: Map of the southern rift apron and surrounding areas of Ascraeus Mons showing the features mapped by the students.

various morphological features associated with the channels. 3) Measured various parameters such as aerial extent, cross-sections and channel gradients. 4) Described and interpreted these morphological features based on our understanding of geological processes on Mars. 5) Compared these features to analog features on the earth (including observations made during a five day trip to Hawai'i). 6) Interpreted the origin of these features based on these initial observations and attempted to develop criteria to distinguish fluvial and volcanic features. 7) Place the formation of these features into the broader context of the geological evolution of Mars by mapping their boundaries to determine their relationship with other volcanic (and fluvial) deposits. Part 2, is ongoing and involves the completion of 1) A similar study in another location in the Ascraeus area – eg the northern apron which appears to have similar channels. 2) Study similar features on one of the other Martian volcanoes such as Pavonis. 3) Contrast these channels with Martian channels that are almost certainly formed by flowing water – eg. Kasei Valles or Shalbatana Vallis. Examine the similarities and differences between these channel features. 4) Combine analog studies into the interpretation of the Martian features.

Broader goals of the project: exposure the students to planetary geology; provide a greater appreciation of the role of NASA in planetary exploration and research; develop experience in doing original research; work together in a team of researchers with a common goal; exposure to research with a broad appeal and relevance.

References: [1] Bleacher et al. (2010) *LPSC*, #1612. [2] Murray et al. (2010) *E & P Sci. Letters*. [3] Collins et al. (this issue). [4] Schierl et al. (this issue). [5] Signorella et al. (this issue). [6] Leverington, (2004) JGR doi:10.1029/2004JE002311. [7] Bleacher et al. (2008) JGRE doi:10.1029/2006JE002873. [8] Trumble et al. (2008) LPSC, #1391. [9] Mouginis-Mark and Christensen (2005) *JGRE*, doi:10.1029/2005JE002421.